Microcomputer Applications Handbook

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William P. Woodall, Technical Editor

Nancy Hayfield, Production Editor

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Contributors

Morgan Adair, Software Consultant, New York City

Jonathan Amsterdam, Artificial Intelligence Laboratory, Massachusetts Institute of Technology

William Bailey, BASIS, Inc., Chatham, New Jersey

Scott Berfield, Parity Productions, Chicago, Illinois

Jeffrey D'Ambrosia, DHI Contracting, Greenbrook, New Jersey

Brig Elliott, True BASIC, Inc., Hanover, New Hampshire

Ian Harac, Software Consultant, Fords, New Jersey

Harry L. Helms, Software Consultant, Guttenberg, New Jersey

John Hild, XYQUEST, Inc., Bedford, Massachusetts

Michael Iannone, Department of Mathematics and Computer Science, Trenton State College

Paul D. Lehrman, Musician and Software Consultant, Arlington, Massachusetts

Robert Levine, UNYSIS, New York City

Len Lindsay, COMAL Users Group USA, Ltd., Madison, Wisconsin

Karl Nicholas, Physical Acoustics Corporation, Princeton, New Jersey

Erwin Noble, The Victor Wortman Company, Santa Monica, California

Contributors

Ross Overbeek, Argonne National Laboratories, Lisle, Illinois

P. J. Plauger, Whitesmiths, Ltd., Westford, Massachusetts

Jim D. Porter, Motorola, Inc., Austin, Texas

Mark J. Robillard, Systems Consultant, Milford, New Hampshire

Al Rubottom, New Technica, Inc., San Diego, California

Stephen E. Seadler, Uniconsult, New York City

Thomas Sheldon, Author and Consultant, Santa Barbara, California

Kern E. Sibbald, Auto CAD, San Francisco, California

Ernest R. Tello, President, Integral Systems, Santa Cruz, California

Paul Thomas, Force Field, San Francisco, California

Michael Tilson, Vice President, Human Computing Resources Corporation, Toronto, Ontario

Michael Wetmore, Chief of Engineering, Pierce-Phelps, Inc., Philadelphia, Pennsylvania

Robert Wharton, Professor of Mathematics, Department of Mathematics and Computer Science, Trenton State College

Roy Woodall, AT & T, Western Electric, Piscataway, New Jersey

William P. Woodall, Software Specialists, Somerville, New Jersey

Preface

The *Microcomputer Applications Handbook* is intended to be the desktop source guide to the applications universe of personal computing. It addresses the applications nature of personal computer hardware systems, operating systems, high-level programming languages, and applications software systems from a user's rather than a programmer's perspective. The book was written for PC users who want to understand the depth and extent of their systems' abilities and seek to learn the range of the applications they can implement. The articles in the handbook are divided into five basic categories: the nature of computer hardware and peripherals; the operating systems that act as the resident hosts for applications programs; the high-level languages that serve as development tools as well as applications; basic applications programs such as integrated software and word processing; and special applications programs such as music, artificial intelligence, computer-aided design, and desktop publishing. There are also two hybrid articles—multiuser systems and local area networks—that deal with hardware, operating systems, and applications software issues at the same time.

The articles in the *Microcomputer Applications Handbook* also provide a working history of the development of microcomputer implementations from the earliest operating systems and word processing applications of the 1970s to the integrated desktop software packages running under OS/2 and MultiFinder. The *Microcomputer Applications Handbook* profiles the growth in the power and complexity of microcomputer software and explains how the needs of business and professional users created a demand for applications in which increasing amounts of data management capability were packed into off-the-shelf programs.

With articles that range from the basics of hardware systems to the design and architecture of neural networking models of knowledge acquisition software, the *Microcomputer Applications Handbook* is the most complete and up-to-date handbook on personal computer applications currently on the market. This single-volume reference will help the novice desktop computer user understand the power and range of his or her system while at the same time guide the more experienced user in designing the ultimate personal software implementation.

William J. Birnes
Editor

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HARDWARE SYSTEMS

During the short history of the microcomputer, the "typical" system has progressed from a small box of electronics, a few switches, and a small LED display to full-blown engineering workstations capable of feats only imagined in the research labs of yesteryear. Even since the publication of the first edition of the *Programmer's Encyclopedia* in 1985, the size, architecture, amount of addressable memory, data-storage capacity, speed, and processing power of the personal computer system has changed dramatically. However, the concept of the personal computer—an individual workstation that can function as a self-contained computing facility, a data-sharing terminal on local area network, or a telecommunications device—has not changed fundamentally. It is still a programmable desktop appliance that can interface with a universe of digitalized information banks and transmission/receiving systems. With the introduction of true 16- and 32-bit microprocessor technology since 1983, the range of personal computing applications has broadened to the point where the actual difference between microcomputers and minicomputers has become very small. Accordingly, even though they were once dedicated to specific tasks such as word processing or localized data processing, personal computers have increasingly replaced minicomputers, even for the larger tasks of data acquisition, integrated data processing, process control, computer aided design and manufacturing, and remote control systems.

The basic business microcomputer of today is a system comprised of a microprocessor and all its supporting hardware, both in the form of direct support chips assisting in the management of memory and other devices, as well as a source of power. The basic design, as the block diagram in Fig. 1–1 illustrates, encompasses one or more input devices such as keyboards and numeric pads, a mouse, digitizing tablet, or game paddles; video display terminal for output; storage devices such as floppy disks, a hard disk, or a CD-ROM; a printer; and a telecommunications device such as a modem. These devices also have broad ranges of functions from simple, relatively inexpensive dedicated applications to sophisticated, multifunction capabilities. For example, in desktop publishing and electronic page-making applications, the simple, low-resolution monitor is not sufficient. Large page-size monitors are necessary in these instances to give the page designer or graphics artist the capability of seeing the entire page or two facing pages at the same time without having to scroll up and down the screen. And for CAD applications, sensitive, board-sized digitizing tablets are necessary to give the draftsperson enough room to create a blueprint-sized document on the screen.

As a general rule, a microcomputer provides the resources for working memory, mass storage, input, and output devices. Special-purpose microcomputers built for industrial process control or other chores will certainly differ in their structure. While the precise nature of these devices will be discussed in greater detail below, the most common devices used are RAM and/or ROM memory, disk storage, a keyboard, and a video display. For business and serious hobby use, a printer is attached as well.

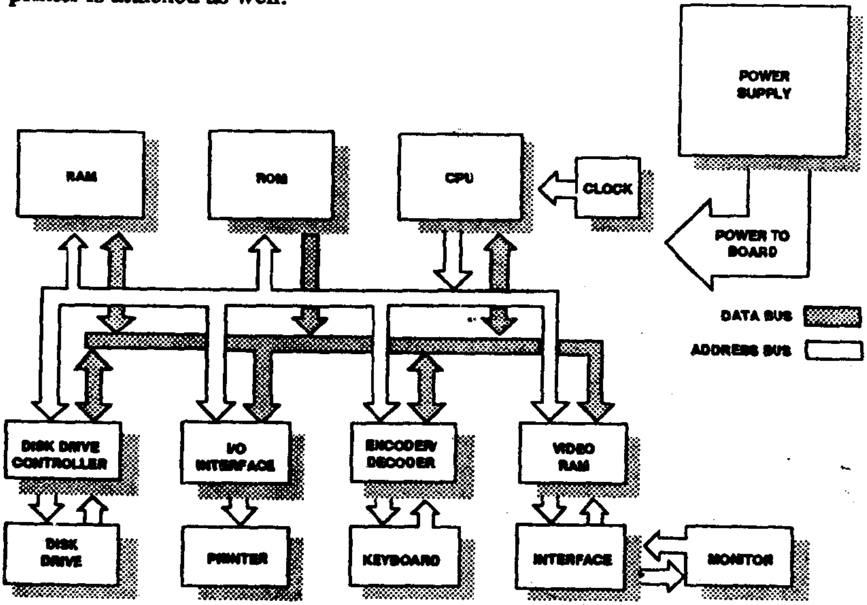

Fig. 1-1

While precise construction details may vary, microcomputers are usually built following one of three major designs: single board, single board with slots (open-architecture), and card cage. Each design has its advantages and disadvantages, and no one style is necessarily superior. Single-board construction, with or without slots, is the most popular and least costly approach. Single-board computers have all the major components of the system contained on a single printed circuit card. Among the major single-board systems are those from Apple, IBM, Commodore, and Atari. The presence of "slots," which are actually card-edge connectors, is a matter of manufacturer philosophy and/or cost factors. "Open-architecture" systems generally feature user-accessible slots, for the addition of hardware to the system. Closed systems rarely provide for any user expansion of the system. Systems with slots are generally considered more flexible, but also more costly. The other major design is "card-cage" construction, consisting of a "backplane" with many card-edge connectors, into which the various cards composing the computer system are plugged. Card-cage construction is virtually universal among mini- and mainframe computers, but has been relatively unpopular in microcomputers.

Among personal microcomputers, four principal system packaging configurations have emerged: laptop portable, transportable, desktop, and tower. The enclosures contain varying items, but the basic components are common to all, of microprocessor, system memory, mass storage, and power supply. Oldest, and most common, is the desktop system. Towers are simply desktop enclosures mounted endwise on the floor, although a few systems are specifically designed for this mounting style. Transportable systems enclose all the major components of a system, including display and keyboard into a single "portable" unit. Laptop systems are battery-powered, miniaturized variants of transportable systems.

Processor and System Memory

Microcomputer systems are centered around the microprocessor type used. With large computers, users are rarely concerned with the details of the processor, but thus far, the microcomputer community must be concerned with this knowledge. Microprocessors generally fall into "families" from particular manufacturers, and, while a good degree of compatibility exists within a family, inter-family compatibility is generally poor. The major concern here is with software; many packages may exist for a given application for one family of microprocessors, but may not exist at all for another family. Major families as of this writing are Intel, Motorola, Zilog, National Semiconductor, Mostek, and NEC.

Microcomputers are generally classified into convenient categories of 8-bit, 16-bit, or 32-bit systems. The designation "x-bit" is derived from the width of the microprocessor's data bus width, between the processor and system memory. The larger the "-bit" designation, the more powerful the microprocessor. Figure 1–2 illustrates the block diagram of a Z80 processor.

System Memory. This encompasses memory available for program and program working storage. Memory is typically split into two types within a microcomputer, RAM and ROM. RAM (random access memory) is more properly termed read/write memory, or memory that can be read by the microprocessor as well as written to. RAM size for a particular microcomputer is limited either by microprocessor design or the wealth of the purchaser. In early 8-bit microcomputers such as the Tandy TRS-80 Model I, 16 kilobytes (1024 bytes = 1 K) of RAM was the standard, with a maximum of 48K. CP/M systems, also based on 8-bit microprocessors, allowed a maximum of 64K. The IBM PC, a later 8-bit design, has a maximum

RAM allocation of 640K. With the advent of 16-bit and 32-bit microprocessors, maximum RAM in a machine is more likely to be limited by cost factors than by actual processor limits; the 8086 microprocessor is limited to 1 megabyte (1,024 K) total memory, the 80386, 4 gigabytes (4,096 megabytes). Other 16- and 32-bit designs have similar design limits.

RAM is further divided into three distinct electronic types, based on the precise method by which a bit of information is stored. RAM is volatile; when power is removed all RAM contents are lost. Dynamic RAM, or DRAM, is overwhelmingly the common RAM type. The DRAM stores a bit as a charge within a capacitor. Since a capacitor slowly drains any charge held, DRAMs require "refresh" of all bit locations within memory at a periodic rate. The term *dynamic* comes from this continuous cycling of memory to maintain charge. Although refresh does add overhead to the operation of the machine, it is offset by simple construction and relatively low power requirements. Static RAM, or SRAM, does not require refresh, and stores a bit in a bistable latch or "flip-flop" network of transistors. SRAM can be accessed more quickly than DRAM, since there is never a wait for refresh. The third type of RAM is bipolar RAM, actually a variant of SRAM. Bipolar devices are extremely fast, very power-hungry, and quite costly.

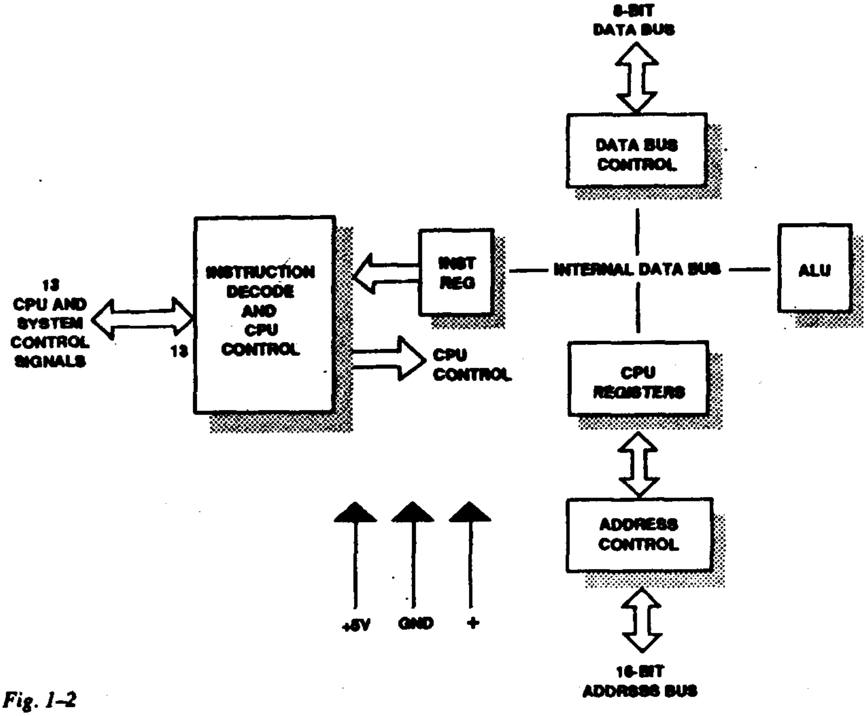

Fig. 1-2

Memory Cache. Current usage for bipolar RAM is in memory cacheing, the duplication of other RAM memory in a special area in an attempt to increase microprocessor performance. Cacheing in microcomputers is limited to 32-bit systems as a way of using lower cost DRAM with a processor which can access RAM faster than the DRAM can respond. In a cached system, a special cache controller selectively copies from DRAM while the microprocessor is executing an instruction. ROM (read-only memory) is nonvolatile, impervious to loss of power. ROM is used to store nonchanging programs or data for the computer. ROM is first used by a system during power-up, to perform various system tests and to "boot," or initialize the operating system program for the system. In some microcomputers, the entire operating system is itself resident in ROM. Other systems simply use the ROM to perform the boot load, then turn ROM off. More typically, ROM contains the BIOS (basic input-output system), which is the fragment of the operating system used to control standard peripherals such as the keyboard, video display, and diskette storage.

ROMs subdivide into four types, based on how programs are entered into the ROM. The types are: ROM, PROM, EPROM, and EEPROM or EAROM. The ROM (also referred to as a "mask-programmed ROM") is fabricated with contents already in place, unalterable forever. The PROM (programmable read-only memory) is a ROM with no contents; it may be written to exactly once, after which it cannot be changed. The EPROM (erasable programmable read-only memory) is a PROM which can be repeatedly erased with ultraviolet light. The EEPROM/EAROM (electrically erasable programmable read-only memory/electrically alterable read-only memory) is a PROM which can be erased by the application of current over time to the device, allowing the EEPROM to be changed while installed in a machine. A common use for this device is to store default parameters within an "intelligent" modem or printer.

Input Devices For Data Entry

Front-panel Switches. The earliest hobbyist microcomputers used series of switches on the front of the system enclosure for data entry and system control. Reminiscent of movie computers, these data-entry devices are obsolete, and rarely seen. Current microcomputers may allow for a system reset switch on the front or rear of the machine, or a security keyswitch that disables keyboard and disk drive usage.

Keyboard. The standard data-entry device of microcomputers, keyboards are standard equipment with all production microcomputer systems. The number and layout of keys, the method by which the keyboard communicates to the microprocessor, and the type of switches used in the keyboard are the salient points. A keyboard is a matrix of switches used to enter data into a computer. All microcomputer manufacturers currently use some variant of the ASCII (American Standard Code for Information Interchange) code for storage of information within the computer, and most keyboards can generate all ASCII codes as well as various manufacturer-specific extended codes. Microcomputer keyboards are either parallel or serial devices communicating with the microprocessor in a device-specific code; older microcomputers use parallel keyboards, which are mounted permanently in the same housing with the microprocessor itself. Newer designs predominantly use serial-encoded keyboards, which allow for the keyboard to be detached from the main microcomputer enclosure. Work efficiency studies continue to suggest that detached keyboards, which can be moved about, provide the greatest productivity.

Keyboards use a variety of switch types: the main styles are soft-touch, where a low-pressure keystroke of short vertical travel produces the character; full-travel, where a firmer press is needed and the key presses more fully; and membrane, where a touch to a spot on the keyboard makes the contact, with no travel or "key" at all. Membrane keyboards are used in harsh environments, such as the factory floor or as a game system for children.

Keyboards communicate with the microprocessor via cable attachment or infrared transmitter/receiver. Cable attachment may be internal and unchangeable as in the case of the Commodore C64, Atari ST, or Amiga 500 (all of which integrate the keyboard into the top of the main system housing), or flexible, as is the case with most PCs, the Apple Macintosh, and others. Cordless infrared systems have been offered periodically, usually as part of a home/hobbyist system. The need for battery replacement and clear line-of-sight between computer and keyboard have kept cordless keyboards out of the business environment.

Layout is the biggest area of keyboard variation. While virtually all keyboards use the traditional QWERTY layout of typewriter fame, once away from the alphabet keys layouts differ radically, sometimes even within the offerings of a manufacturer. However, common keys on almost all microcomputer keyboards are "Control" for generating control or special codes, cursor (arrow) keys for moving the cursor about on the screen, and a number pad. Many keyboards also include alternate shift keys and various function keys, for dedicated (nonchangeable) actions or user-definable actions. Keyboards intended for the business environment also generally have a few status display lamps, indicating shift status and other control information.

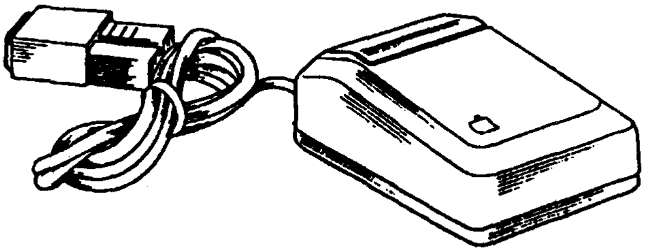

Fig. 1-3

Mouse. The computer "mouse" is a small box with a roller inside, attached to the computer via cable or infrared transmitter, that provides an alternate source of cursor movement (Fig. 1-3). The mouse has two or three selection buttons mounted across the top front surface. As the mouse is moved across a flat surface, potentiometers or other measuring devices translate the movement into cursor movements for the computer. The mouse is becoming an essential tool for computer usage, as more and more software comes to rely on the availability of the mouse to point to and then, in combination with its buttons, select areas of the screen to perform actions on. Mouses have resolutions of around 200 points per inch, so that movement is proportional to, but far less than, actual onscreen measurement.

Two versions of the mouse exist: mechanical, relying on analog measurement of distance rolled on a surface; and electronic, using optical measurement of distances moved across a reflective grid. Mechanical mouses have the advantages of lower cost and proportional movement, but do pick up dust and dirt. Optical mouses require an external power source and a special work surface to operate on.

Joysticks and Trackballs. The joystick (Fig. 1–4) is a simple pointing device, consisting of a stick centered between switches. Moving the stick in a direction provides substitute cursor movement in the indicated direction. The trackball is a mouse mounted upside down, with the roller ball exposed. Joysticks are low-resolution devices, suitable for game playing. Trackballs can be of as high a resolution as mouses, but are most often also used as game-playing devices.

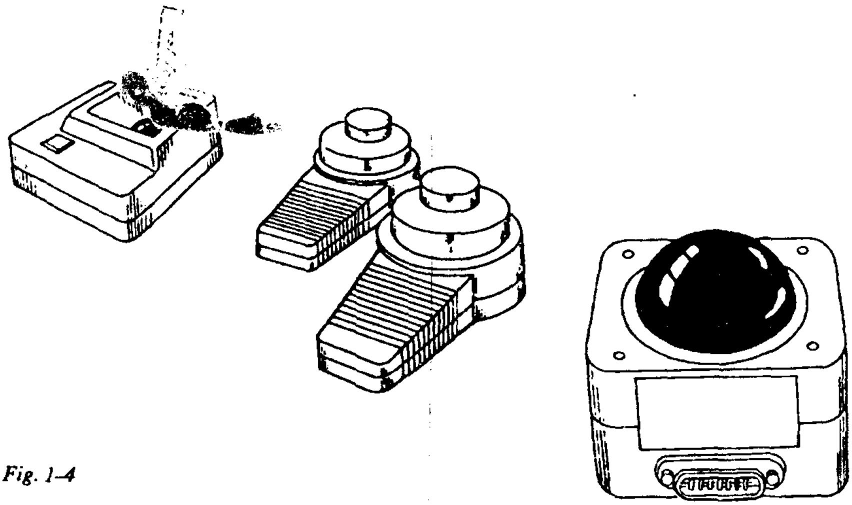

Fig. 1–4

Digitizing Pad. The digitizing pad (Fig. 1–5) is a pointing device made of a grid surface, or pad, in which is embedded sensory electronics for sensing the presence of a stylus. While all digitizing pads are simply reporting the relative position of the stylus on the pad, the manner in which this is accomplished varies between different pads. Some pads use a stylus mounted in a rigid armature, which has sensors at its pivot points. Moving the armature results in the sensors reporting movement and position. Other pads use a network of microswitches, and sense the pressure of the stylus. Another technique is the use of a mouse as the stylus, and still other pads use infrared sensors to detect an invisible light source from the stylus. Digitizing pads are widely used to enter drawings into computers, for CAD-CAM purposes.

Touch Screen. The touch screen is a sensory frame placed around the edge of a conventional video display, using electric-eye technology to detect the user's finger breaking the beam at a particular point as the user touches the screen. Some touch screens use a pressure sensitive overlay directly on the monitor face to acquire the data. The touch screen is best suited for occasional use in an application requiring only a few choices. Due to the need to repeatedly reach up and touch the screen, coupled with the lack of precision in pressing a particular point onscreen, the touch screen is typically used only for special purpose systems of limited facility. Common applications of the touch screen are in airport or hotel information-referral systems, and other uses where minimal data entry is required.

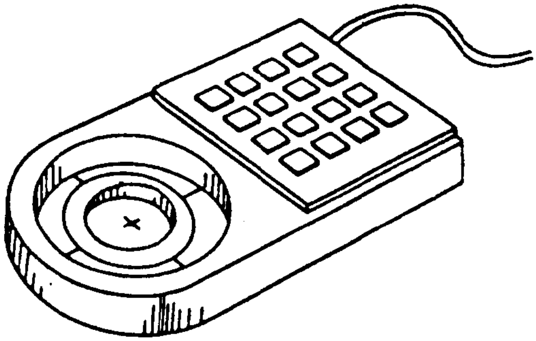

Fig. 1–5

Lightpen. The lightpen is a photoelectric sensor mounted in a tube, typically a penlike housing (Fig. 1–6). Although called a pen, the lightpen doesn't write, it only reads. The lightpen senses a block of light from a computer display. Significant software overhead is necessary for lightpen operation, since the software must create the light block, await the lightpen signal, then act accordingly. Because of the software overhead involved, as well as the relative imprecision of the operation, lightpens have become something of a curiosity rather than a widely used data-entry device.

Bar-code Reader. While bar codes are most commonly associated with pricing merchandise in a grocery store, bar-code readers are becoming more prevalent as a microcomputer input device. A bar-code reader is a variation of a lightpen, but includes a light source as well, and reads the reflected light as it is passed over the code.

Graphics and OCR Scanners. The graphics scanner is a device allowing the rapid conversion of pictorial information into digitized form for computer storage and manipulation. All scanners operate by reading reflected light from the material (usually paper) to be scanned. A scanner may have only a single pickup element, or an array of elements. Scanners come in two styles and four major types. The styles are basically line-at-a-time, and full page readers. Line-at-a-time scanners subdivide into two types, handheld and printhead mounted. Handheld scanners generally